

**UNCLASSIFIED**

**406 405**

---

**AD**

**DEFENSE DOCUMENTATION CENTER**

**FOR**

**SCIENTIFIC AND TECHNICAL INFORMATION**

**CAMERON STATION, ALEXANDRIA, VIRGINIA**



**UNCLASSIFIED**

**NOTICE:** When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

406405

AD NO.

FILE COPY

406 405

JPRS: 17,333

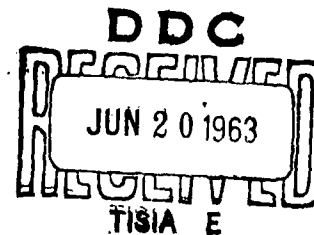
28 January 1963

S&T

*Scale-1*

10

TRANSLATIONS ON RESPIRATION INJURIES AND  
HYDROLYSIN L-103 NUTRITION FOR CHILDREN  
- USSR -



U. S. DEPARTMENT OF COMMERCE

OFFICE OF TECHNICAL SERVICES

JOINT PUBLICATIONS RESEARCH SERVICE

Building T-30

Ohio Drive and Independence Avenue, S.W.  
Washington 25, D. C.

Price: \$.75

## FOREWORD

This publication was prepared under contract for the Joint Publications Research Service, an organization established to service the translation and foreign-language research needs of the various federal government departments.

The contents of this material in no way represent the policies, views, or attitudes of the U. S. Government, or of the parties to any distribution arrangements.

## PROCUREMENT OF JPRS REPORTS

All JPRS reports are listed in Monthly Catalog of U. S. Government Publications, available for \$4.50 (\$6.00 foreign) per year (including an annual index) from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

Scientific and technical reports may be obtained from: Sales and Distribution Section, Office of Technical Services, Washington 25, D. C. These reports and their prices are listed in the Office of Technical Services semimonthly publication, Technical Translations, available at \$12.00 per year from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

Photocopies of any JPRS report are available (price upon request) from: Photoduplication Service, Library of Congress, Washington 25, D. C.

TRANSLATIONS ON RESPIRATION INJURIES AND  
HYDROLYSIN L-103 NUTRITION FOR CHILDREN

- USSR -

[Following is the translation of three articles  
from the Russian-language publication Vestnik  
Khirurgii (Herald of Surgery), Leningrad, Vol 89,  
No 11, 1962. Additional bibliographic data accom-  
panies each article.]

TABLE OF CONTENTS

	<u>Page</u>
Burns of the Respiratory Tract	1
Electrostimulation of the Diaphragmatic Nerves During Apnea	11
Experience with the Use of Hydrolysin L-103 in Children	20

## BURNS OF THE RESPIRATORY TRACT

Following is the translation of an article by Candidate of Medical Sciences L. M. Klyachkin, Candidate of Medical Sciences V. M. Pinchuk, V. N. Khrebtovich, and R. N. Katrushenko in the Russian-language publication Vestnik Khirurgii (Herald of Surgery), Leningrad, Vol 89, No 11, 1962, pages 41-48.

From the Department of Thermal Injuries (Head -- Professor T. Ya. Ar'yev) and from the Scientific Research Burns Laboratory (Director -- Doctor of Medical Sciences Ye. V. Gubler) of the Military-Medical Order of Lenin Academy imeni S. M. Kirov (Scientific Director -- Professor N. S. Molchanov)

Burns of the respiratory tract are frequently encountered in thermal injuries, considerably aggravating their course. Cases of such burns have been described for accidents in 1942 in Boston (Aub and Pittman, 1943; Mallory and Brickley, 1943) and in Cleveland in 1954 (Shenk and Stephens, 1955) on the American aircraft carrier "Bennington" (Enyart and Miller, 1959).

In 1945 Moritz and McLean, as a result of experiments on animals, suggested that if the thermal agent inhaled is potentially capable of injuring the respiratory tract below the larynx, then it will undoubtedly cause a fatal edema to the larynx. This opinion was carried over into the clinical aspect of burn injury and has been repeated by several authorities up to recent times (in particular, by Sevitt, 1957), although direct clinical observations (Aub and Pittman, Enyart and Miller, etc.) clearly contradict such a view.

It is apparent that because of the inadequate diagnosis of burns of the respiratory tract lay also in the search for such "indisputable" signs of damage to the larynx as aphonia and asphyxia. On the other hand, the regular development in such patients of more delayed severe, and sometimes even fatal pulmonary complications urgently necessitated a profound study of the problem, in particular, in its diagnostic and therapeutic aspects.

Analysis of our clinical and pathologo-anatomic observations has shown that in recent years (up to 1959), when the symptom complex of burns of the respiratory tract was still not sufficiently clear, these lesions were diagnosed not for all cases by far. The diagnostic difficulties arose for the more severe burns, when death occurred after one to two days and the examination of the victims could be carried out only to a most minimum extent.

Since 1959 only 31 patients with burns of the respiratory tract have come under our observation. Of these, 22 died.

For most patients the combination of lesion in the respiratory tract with extensive deep burns of the skin was characteristic. For only five patients was the total area of the burns 10-25%, for all the others the area varied within the limits of 30-95% of body surface. Also characteristic was the localization of the burns -- thirty of 31 patients were burned in the face and neck, lip burns were observed, hair was singed. The conditions of the trauma also deserve attention. Four victims were burned during cooking, seven -- during various explosions, 15 victims had their clothes set afire. One patient fell into a hot cupola furnace. Steam burns were observed for four patients.

In the clinical picture of the first days following the burn dyspnea could be noted: respiration was difficult, hoarse, and at a rate from 18 to 24 times a minute. For individual patients broken dry rhonchi in the lungs could be heard. The patient spoke with difficulty, in part due to unpleasant sensations in the throat, in part due to the beginning edema of a burned tongue, the voice sometimes was hoarse, but none of the patients had complete aphonia, and the difficulty in respiration was never due to the direct threat of asphyxiation. During the course of one to two days ten patients died, not coming out of shock. The seriousness of their condition limited the possibilities of study, in particular, roentgenological.

The maximum development of the edema of the burned skin by the second to third day following the burn made possible consideration also of the growing edema of the respiratory tract affected. Usually the dyspnea increased. In two patients aphonia set in. However, none of these patients were troubled by asphyxia. Physically, a variegation of the percussion data was discovered. Sections having a box tone alternated with dull tympanites. Enfeebled, and less often hard, breathing and broken dry bronchi and crepitations were heard. These data were usually treated as symptoms of bronchitis and broncho-pneumonia. In subsequent days catarrhal effects in the lungs increased. This entire picture developed against a background of fever with increase in body temperature up to 40-41°, with delirium, and sometimes with psychotic effects. In the terminal period edema of the lungs developed with the characteristic gurgling respiration.

In four patients who became victims during the explosion of a steam kettle, in spite of a prolonged exposure (about five minutes), the damage to the respiratory tract was only very moderate. Pneumonia developed only in one of these patients, all of the victims recovering. It is known that in experiments steam causes the most severe lesions of the respiratory tract. It is obvious that in accidents the steam rapidly condenses in the surrounding air, which sharply reduces its damaging action.

Examination of the nose, mouth, pharynx, and larynx was carried out for 14 patients. For seven of the patients, the laryngo-cto-rhino-organs could be examined the day following the trauma. In three of these cases, dry hyperemic mucous larynx covered by a viscous white secretion was observed; hyperemia and restriction of the mobility of the true vocal cords, as well as incomplete closure of the cords during phonation. For four patients only hyperemia of the oral mucosa, alternating with whitish areas, could be noted, as well as hyperemia of the larynx and epiglottis. Examination by a laryngologist of the remaining patients was carried out by the seventh to tenth day and revealed hyperemia and a moderate edema of the mucous larynx and false vocal cords.

Roentgenological examination of the organs in the thoracic cavity was carried out for 17 patients. During the first days changes in the lungs did not appear. Subsequently, a darkening of the pulmonary fields was observed, which was of a focal character. In individual cases, the roentgenological data made it possible to speak of atelectasis, usually lobular.

Upon autopsy for all the patients who perished in the first days, the mucous membranes of the respiratory tract were somewhat edemic, considerably plethoric, mottled by small hemorrhages and ulcuscles. Accumulations of thick viscous mucus was found in the lumen of the bronchi (usually the small bronchi), and sometimes even in the lower portion of the trachea; the kollabirovannye [?] sections of the pulmonary parenchyma were collapsed (Figure 1). The ordering divisions of the lungs were emphysematously distended. The pulmonary tissue was continually acutely plethoric, under the visceral nerve and in the tissues of the lungs there were multiple foci of hemorrhages; in one of the patients who died numerous infarcta were discovered. Microscopic examination revealed the non-uniformity of the lumen of the bronchi, and the accumulation therein of mucus, desquamated epithelia, erythrocytes, and by the end of the first days -- leucocytes as well. The congested plethora of the lungs was accompanied by the development of capillary stases and the appearance in the arteries and the veins of numerous thrombi. In the alveoles and in the stroma of the lungs sizable accumulations of edemic liquid was detected.

In the patients perishing by the second to third day, and subsequently, fibrinose-suppurative impositions appeared on the



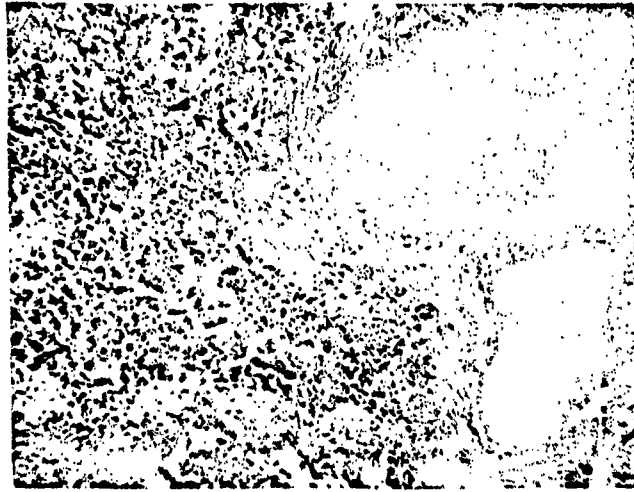


Figure 1. Lumen of a small bronchus filled with layers of desquamated epithelium and leucocytes; at the side -- a vessel covered with a thrombus. Death followed 18 hours after the trauma. Stain used was hematoxylin-eosine. Microphotograph. X 280.

mucous membranes of the trachea and the large bronchi; the edema by this time decreased, but the hyperemia remained (Figure 2). It must be noted that in all of the cases studied by us the burns of the respiratory tract could be qualified as first to second degree burns. Microscopic examination showed that by the tenth to twelfth day the epithelial covering of the larynx and the trachea was restored almost completely, in which, as a rule, in the trachea a multi-layer plane developed at the site of the cylindrical epithelium (Figure 3). In the patients, by the end of the second day after the trauma, small foci of suppurative-fibrinous or suppurative-necrotic pneumonia (Figure 4) was found. In the cases of death after three to four days and later pneumonia was always of the distributed large-focal, confluent, and even lobar type. For three of the victims autopsy revealed numerous abscesses; upon microscopic examination small foci of suppurative inflammation of the pulmonary parenchyma was discovered in almost all cases. The inflammatory process arose initially in the bronchi, evidenced by the distributed suppurative bronchitis and bronchiolitis, noted for the patients who died already during the first days following the trauma (Figure 5). From the bronchi the inflammation easily moved into the peribronchial tissue (in individual cases the entire wall of the bronchus proved to be



Figure 2. Edema and plethora of the submucous layer of the trachea. On the surface are layers of desquamated epithelium, fibrin, and leucocytes. Death followed two days after the trauma. Stained according to Van-Gizon. Microphotograph. X 280.

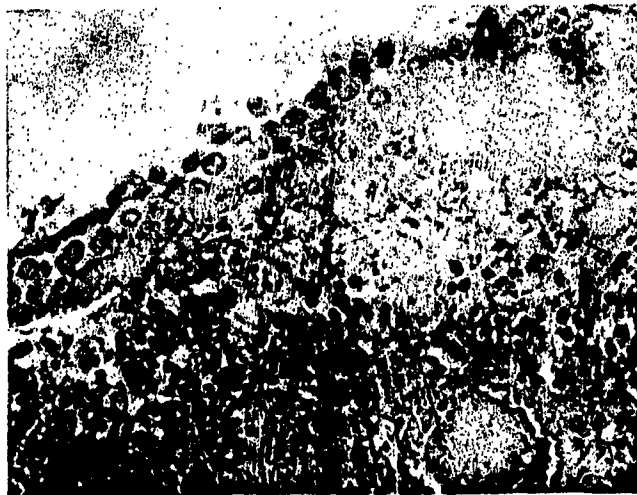


Figure 3. Proliferation of multilayer flat epithelium on the surface of the trachea. Edema and plethora of the submucous layer. Death on the 12th day following the trauma. Stained according to Van-Gizon. Microphotograph. X 400.

suppuratively inflamed) and the parenchyma of the lungs. The generalized disturbances of blood circulation and, especially, the edema of the pulmonary tissue promoted a rapid spread of the inflammation throughout the organ, leading to the development of extremely severe pneumonia, which proved to be the cause of death of the victims. It must be emphasized that not in a single observation was the fatal outcome a consequence of asphyxiation on the grounds of edema of the larynx.

To explain the role of various factors in the emergence of burns of the respiratory tract 110 experiments were conducted on cats. The animals independently inhaled steam, hot air, or flame. The experiments were carried out without narcosis. The results of the studies are presented in the table. [Comment: See Page 10 of report.]

It turned out that inhalation of steam causes injury to all sections of the respiratory tract in the lungs for an exposure of only two seconds. Upon inhaling tongues of smokeless flame of burning alcohol for thirty seconds the same injuries developed. Heated air at a temperature of 500° and an exposure of four minutes caused damage to the oral mucosa, to the pharynx, and only in a few cases to the larynx. Injuries below the glottis were not observed, apparently as a consequence of the low heat capacity of the air and its intensive cooling over the extent of the respiratory tract. Nonetheless, pulmonary changes in the form of atelectasis, emphysema, and pneumonia were found for most of the experiments.

In the experiments as well as in the clinical aspect, fatal asphyxiation on the grounds of glottidial edema was not observed even in one case, as described by Moritz (1945). The main danger of burns of the respiratory tract lies in the fact that they regularly lead to the development of secondary pulmonary complications, considerably aggravating the course of the burn affection during the first days.

The genesis of lung damage is usually explained by poisoning caused by carbon monoxide or oxides of nitrogen (Aub and Pittman, 1943; Mallory and Brickley, 1943). In our experiments the action of nitrogen oxides was excluded by using alcohol as the source of combustion. As far as carbon monoxide gas is concerned, an exposure of half a minute is, of course, insufficient to cause severe, and sometimes fatal damage to the lungs.

On the other hand, measurement of the temperature in various sections of the respiratory tract in our experiments showed that upon inhaling flame the temperature under the mucosa of the upper sections of the trachea reached 50°. In these instances necrosis of the mucosa was observed. On the surface of the mucosa of the middle bronchi the temperature rose to 43-47°, that is, it did not reach the critical value. This enabled us to consider that changes in the lungs cannot be reduced to direct burning of their tissues. Pulmonary disorders obviously have a more complex pathogenesis. Savitt (1957) explained the emergence of atelectasis only by the

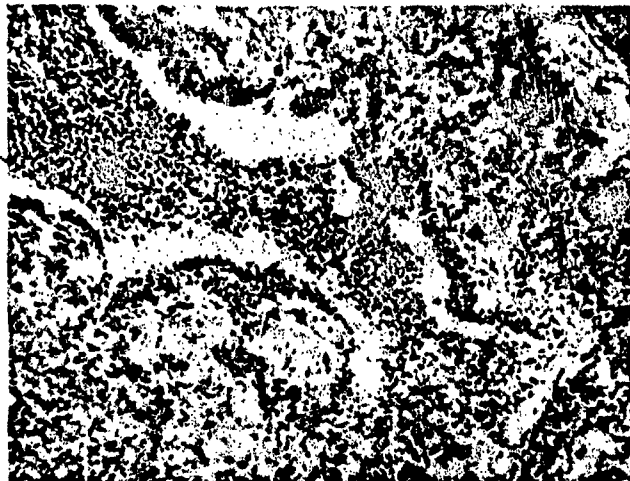


Figure 4. Suppurative bronchitis and suppurative pneumonia. Death on the 15th day following the trauma.  
Stained: hematoxylin-eosine. Microphotograph. X 280.



Figure 5. Suppurative bronchitis. Wall of bronchus fused over a limited extent. Death on the third day following the trauma.  
Stained: hematoxylin-eosine. Microphotograph. X 280.

plethora of the lungs. However, there is no doubt that the bronchiolitis developing soon after the burn, entailing disorders of the drainage function of the small bronchi, becomes the cause for atelectasis and emphysema. Worsening of external respiration can also be related to a decrease in the respiratory excursions due to the associated burns of the thoracic cavity. This same fact complicates the elimination of bronchial mucus through coughing.

Early diagnosis of respiratory tract burns and of their consequences increases the effectiveness of treatment. The main task in treatment must be the drainage of the bronchial tree. Along with this, it is necessary to establish conditions facilitating gas exchange in the lungs. One of the most promising methods in this regard is tracheostomy with subsequent, over the course of several days, aspiration of the bronchial content, constant inhalation of oxygen, and if necessary the administration of antibiotics or nistatine through tracheostomy. Tracheostomy, in connection with respiratory tract burns, was carried out for nine patients. Five of this group were operated on in the first days following the trauma, two patients on the second days, and further on -- two patients. Following the operation systematic aspiration of the bronchial mucus was accomplished by means of deep introduction of a catheter during the tracheostomy, connected with a pumping apparatus, oxygen being continually administered. A. N. Shabanov and V. L. Kassil' (1961) presented convincing data in favor of tracheostomy for manifestations of acute respiratory insufficiency caused by the accumulation of mucus in the trachea and the bronchi due to ineffective coughing, disturbance of the respiratory rhythm, or the depth of respiratory excursions. The mechanism of the action of tracheostomy consists in reducing the dead space of the respiratory tract (Carter and Giuseffi, 1951). Resistance of the respiratory tract following tracheostomy is reduced down to less than one-half (G. M. Zemtsov and A. I. Yudina, 1955); reduction in the excursions of the thoracic cavity no longer leads to a decrease in the volume of the air respired. Tracheostomy increases the oxygen saturation of the blood, especially for aspiration of the bronchial content.

In cases in which aspiration of the mucus through tracheostomy proves to be ineffective in dealing with respiratory insufficiency, a bronchoscopy is performed. It permits an examination of the mucosa of the trachea and the main bronchi and a drawing off of the mucus accumulated therein. Here, the bronchoscope was administered through tracheostomy, since the passage of the instrument through the mouth would be impossible owing to the burns of the face and neck.

In all, a bronchoscopy was carried out by us on five patients, for two of them it was done twice. For three patients it was possible to safely eliminate atelectasis. Thus, for patient X, following distributed burns of the face, neck, hands, trunk, and lesions

of the respiratory tract, a picture of bronchiolitis and bronchopneumonia with increasing respiratory deficiency developed acutely. By the tenth day of the affection a tracheostomy was performed, and on the 16th -- a bronchoscopy, which permitted the discovery of acute hyperemia, edema of the mucosa of the bronchi, and an accumulation of thick mucus therein. Aspiration of the bronchi content was carried out. As a result the atelectasis was eliminated, the patient's body temperature fell off, and respiration slowed down and became freer. Expulsion of sputum was considerably eased. Physically, mild effects of emphysema continued to be noticed. The further course of the disease was wholly favorable.

Bronchoscopy permitted the recovery of the lungs and showed that atelectasis was a consequence of an inflammatory obstruction of the bronchi, besides preventing the unquestionable threat of pneumonia to the patient. Tracheostomy and bronchoscopy have firmly become part of the practice of our clinics in treating burns of the respiratory tract and their consequences.

#### Conclusion

1. Burns of the respiratory tract acutely aggravate the course of the burn affection during the first days. Their main consequence is acute tracheobronchitis and bronchiolitis with disturbance to the passing ability of the bronchial tree, the growth of atelectasis, acute emphysema, pneumonia, and respiratory insufficiency.

2. From anamnestic accounts on the possibility of having inhaled steam, heated air, or flame, and also when deep burns of the face, neck, and chest are involved a laryngoscopy must be carried out of necessity.

3. Thermal injuries to the larynx, even in the absence of signs of its edema, is an indication for emergency tracheostomy with subsequent aspiration of the bronchial content and inhalation of oxygen through the tracheostomy.

4. Developing respiratory insufficiency, especially for physical and roentgenological signs of atelectasis is an indication for bronchoscopy to be performed with aspiration of the mucus through the bronchoscope.

#### Literature

Zemtsov, G. M., and Yudina, A. I., "Characteristics of External Respiration on Patients Given a Tracheostomy", Works of the Scientific Research Institute of the Ear, Throat, and Nose, Moscow, 1955. -- Shabanov, A. N., and Kassil', V. L., "Tracheostomy as a Means of Dealing with Acute Respiratory Insufficiency", Vestnik Khirurgii (Herald of Surgery), 1961, 5, 122-128.

[Comment: Table referred to on page 6 of this report.]  
 Lesions of the Organs of Respiration for  
 Experimental Burns of the Respiratory Tract

a) Термический агент			b) Локализация поражения								m) Исход
e) Вид	d) Темпера- тура, в °C	e) экспози- ция	г) р	г) о	г) г	г) л	г) т	г) к	г) л	г) л	
н) Пар	—	2 сек.	10	10	10	10	10	10	10	10	Гибель на 1-7-е сутки
o) Пламя	400-500	30 сек.	12	12	12	12	12	12	12	12	Гибель на 1-7-е сутки
р) Горячий воздух	400-450	4 мин.	11	11	3	3	—	—	—	7	330 мтн на 1-6-е сутки

LEGEND: a) Thermal agent; b) Localization of the small lesions; c) Kind; d) temperature, in °C; e) exposure; f) Number of experiments; g) oral cavity; h) epiglottis; i) glottis; j) larynx; k) trachea; l) lungs; m) Outcome; n) Steam; o) Flame; p) Heated air; q) seconds; r) minutes; s) Perished on the \_\_\_\_ day; t) Perished on the \_\_\_\_ day.

10,123

CSO: 2454-3

Aub, J. C., Pittman, H., and Brues, A. M., "The Pulmonary Complications: A Clinical Description", Ann. Surg., 1943, 117, 834-840. -- Carter, B., and Giuseffi, J., "Tracheostomy, A Useful Procedure in Thoracic Surgery, With Particular Reference to Its Employment in Crushing Injuries of the Thorax", J. Thor. Surg., 1951, 21, 5. -- Enyart, J., and Miller, D., "Treatment of Burns Resulting from Disasters", JAMA, 1959, 153, 2, 95-100. -- Mallory, T. B., and Brickley, W. J., "Pathology: With Special Reference to the Pulmonary Lesions", Ann. Surg., 1943, 117, 865-884. -- Moritz, A. R., and McLean, R., "The Effects of Inhaled Heat on the Air Passages and Lungs", Amer. J. Path., 1946, 21, 311. -- Sevitt, S., Burns, Pathology, and Therapeutic Implications, London, 1957. -- Shenk, W. A., and Stephens, J. R., "The Treatment of Mass Burns Casualties: Care of the Cleveland Hall School Fire Victims", Arch. Surg., 1955, 71, 196-204.

Address: Klyachkina, L. M.: Leningrad, D-28, Liteynny Proyezd, House No 26, Apt 562.

## ELECTROSTIMULATION OF THE DIAPHRAGMATIC NERVES DURING APNEA

Following is the translation of an article by Candidate of Medical Sciences, R. S. Svidler, and S. A. Geshelin in the Russian-language publication Vestnik Khirurgii (Herald of Surgery), Leningrad, Vol 89, No 11, 1962, pages 75-80.

From the Surgical Department (Head: Professor B. Ye. Frankenberg) of the Odessa City Clinical Hospital No 1 (Chief Physician -- A. S. Teslik)

The successes of anaesthesiology, whose tasks in recent years have gone beyond the limits of anaesthesia proper and have extended to the control of the vital functions of the organism, have occasioned a reexamination of various viewpoints as to apnea. The widely known advantages of controlled breathing, especially in operations on organs of the thoracic cavity, have encouraged many surgeons and anaesthesiologists to regard apnea not only as a possible, but a desirable and even indispensable attribute of intubational narcosis.

The deep depression of breathing to the level of apnea has departed from the heading of fatal complications to the category of inseparable qualities and controllable properties of modern narcosis. Artificial respiration has become a usual and habitual component in the control of the vital functions of the organism during an operation.

One of the situations dictating the need to use artificial respiration is apnea for high cerebrospinal anaesthesia.

In spite of the many advantages of cerebrospinal anaesthesia over narcosis (minimum dose of toxin substance administered to the organism, absence of general-resorptive action of the anaesthetic, total anaesthesia, and profound relaxation of the musculature), the decrease in arterial pressure and the possible apnea have thus far dissuaded many surgeons from this anaesthetic method.

The preventive stabilization of the vascular tonus, suggested by B. Ye. Frankenberg, by means of subcutaneous administration of



two ml of a 10% caffeine solution and one ml of a 5% ephedrine solution (for 30 minutes before the lumbar puncture) and the sub-arachnoid administration of two ml of a 5% ephedrine solution (immediately before the Sovcaine injection) prevents the drop in blood pressure and safely stabilizes the vascular tonus for the period of cerebrospinal anaesthesia. However, the stabilization of the blood pressure does not prevent depression and apnea, which for total and subtotal cerebrospinal anaesthesia are associated with pharmacological blockage of the motor roots innervating the respiratory musculature. The timely use of artificial respiration permits gas exchange during the period of the paralysis of the respiratory musculature, prevents a secondary drop in vascular tonus associated with hypoxemia, and in the final analysis, has a decisive effect on the course and outcome of cerebrospinal anaesthesia (B. Ye. Frankenberg, 1936, 1960, etc.).

In efforts to find a rational method of artificial respiration, promising for cases of apnea under high cerebrospinal anaesthesia, one of us (R. S. Svidler), from the suggestion of Professor B. Ye. Frankenberg, experimentally developed and physiologically substantiated a method of artificial diaphragmic respiration, induced through rhythmic electroexcitations of the diaphragmatic nerves. The work was done in a laboratory under the supervision of Professor V. S. Galkin. As a stimulus to the diaphragmic nerves an apparatus prepared according to our specifications was used, affording the production of rhythmically interrupted direct current, with a frequency of 50 cycles, and a voltage from one to three volts.

In experiments on cats, dogs, and rabbits, it was shown that the electrostimulation of the diaphragmic nerves leads to rhythmic diaphragmic respiration, whose frequency and depth can be regulated by the apparatus, by changing the rhythm of the stimuli and the voltage of the stimulus current. This data agrees wholly with the results of an experimental investigation of Sarnoff et al (1948-1950). The constriction of the diaphragm during artificial diaphragmic respiration caused a rhythmic reduction in the intrapleural pressure during the inhalation phase, which promoted the sucking action of the thoracic cavity and had a favorable effect on blood circulation. In this way, the mechanism of inhalation during electrophrenic respiration is physiologically closer to the natural condition than for artificial respiration on the basis of insufflation.

Harmoniously combining the reflex stimulation of the respiratory center and its supply of oxygen, electrodiaphragmic respiration proves effective for experimental mechanical and narcotic asphyxiation and apnea as a result of electrotrauma (R. S. Svidler, 1952-1954).

In 1957 the ESD-1 apparatus (electrical respiration stimulator), intended to induce artificial respiration in man (Figure 1) was designed by Engineer N. M. Florianovich, with the consultative

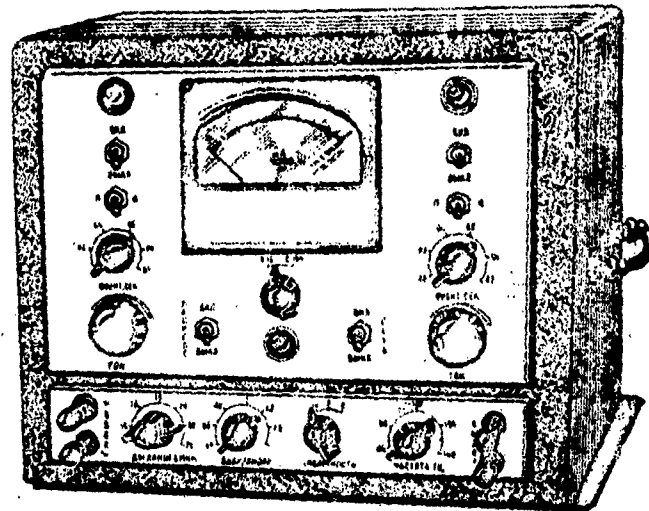


Figure 1. Electrical respiration stimulator (ESD-1).

assistance of Candidate of Medical Sciences R. V. Svidler in the Scientific Research Institute of Medical Instrumentation and Equipment.

The apparatus has two channels -- for the stimulation of active inhalation and exhalation. A series of impulses are generated in each channel, synchronized in such a way that the moment of cessation of current in one channel corresponds to the beginning of current in the other. The ratio of the length of current duration in the channels (that is, the ratio inhalation/exhalation) is regulated smoothly from 0.6 to 1.5. The frequency of succession of the series of impulses (volleys) is regulated from 8 to 32 per minute. The frequency of impulses in series varies from 600 to 140 cycles. The ratio of the length of the pause to the length of the impulse (duty factor) are varied within the limits of three degrees: 3, 5, and 10. The apparatus permits the production of a smooth increase in current strength for each series of impulses, for which the period of increase is controlled from 0.2 to 0.7 seconds. The current strength for each channel is regulated within the limits of two ranges: from 0 to 10, and from 0 to 10 ma <sup>(sic)</sup>. The opportunity of changing the current polarity for each channel is provided for. The apparatus is fed from an alternating current network of 50 cycles, with a voltage of 127 or 220 volts. The maximum usable power does not exceed 90 watts.

The ESD-1 apparatus is supplied with an array of digital, button, and sheet electrodes for excitation of the motor points

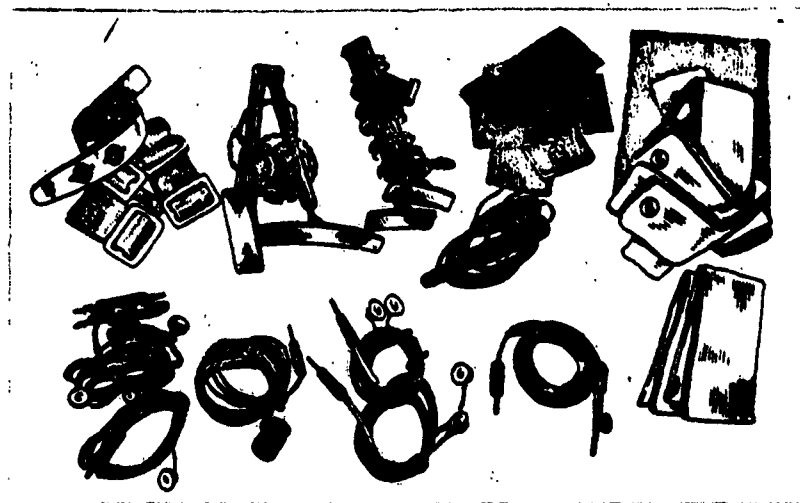


Figure 2. Array of electrodes for the ESD-1 apparatus.

of the diaphragmic nerves, and also of the intercostal muscles and musculature of the abdominal walls (Figure 2). We used only the inhalation channel, stimulating the motor skin points of the diaphragmic nerves by using the digital electrodes; the exhalation proceeded passively.

The restoration of respiratory automatism under conditions of electrostimulation of the diaphragmic nerves not only was not inhibited, but even proceeded more rapidly, according to our impression, than for artificial respiration using insufflation of air.

Artificial diaphragmic respiration with rhythmic stimulation of the skin motor points of the diaphragmic nerves has been dependably induced. The possibility of controlling the length of the respiration phases and the regulation of the period of current strength increase for each series of impulses (smoothness of inhalation) brings the indices of artificial diaphragmic respiration stimulated by the ESD-1 apparatus as close as possible to natural respiration.

Based on the data of the experimental tests, we believed it possible to use the ESD-1 apparatus for apnea during the period of high cerebrospinal anaesthesia under clinical conditions. In all cases, the stimuli were induced at the skin motor points of the diaphragmic nerves, situated in the supraclavicular recesses of the lateral posterior border of the thoracic-clavicular-mammillary muscles.

Electrophrenic respiration by means of the ESD-1 apparatus for apnea during the course of high cerebrospinal anaesthesia has been used by us for seven patients with positive results.

We present a few of our clinical observations:

1. Patient K., 74 years old (original patient No 11411), was operated on 31 August 1959 for cancer of the ascending colon. Puncture between the III and IV lumbar vertebrae. Two ml of a 5% ephedrine solution with bubbling was subarachnoidally administered twice at 8 ml and 0.6 m. of a 1% Sovcaine solution with bubbling 1x8 ml. Total anaesthesia was recorded by the 15th minute. After 20 minutes dyspnea set in.

The electrical stimulation of the diaphragmic nerves by means of the ESD-1 apparatus was used with the following characteristics of the current-stimulus: 60 cycles, 20 ma, 16 stimuli per one minute, inhalation/exhalation -- 0.8, length of increase in strength = 0.5 sec.

A rhythmic, deep, sufficiently smooth diaphragmic respiration was obtained, which eliminated cyanosis and stabilized the steeply falling blood pressure.

On the 25th minute of electrophrenic respiration respiratory automatism was restored, and stimulation of the diaphragmic nerves was halted. A gamikolectomiya / ? / was performed.

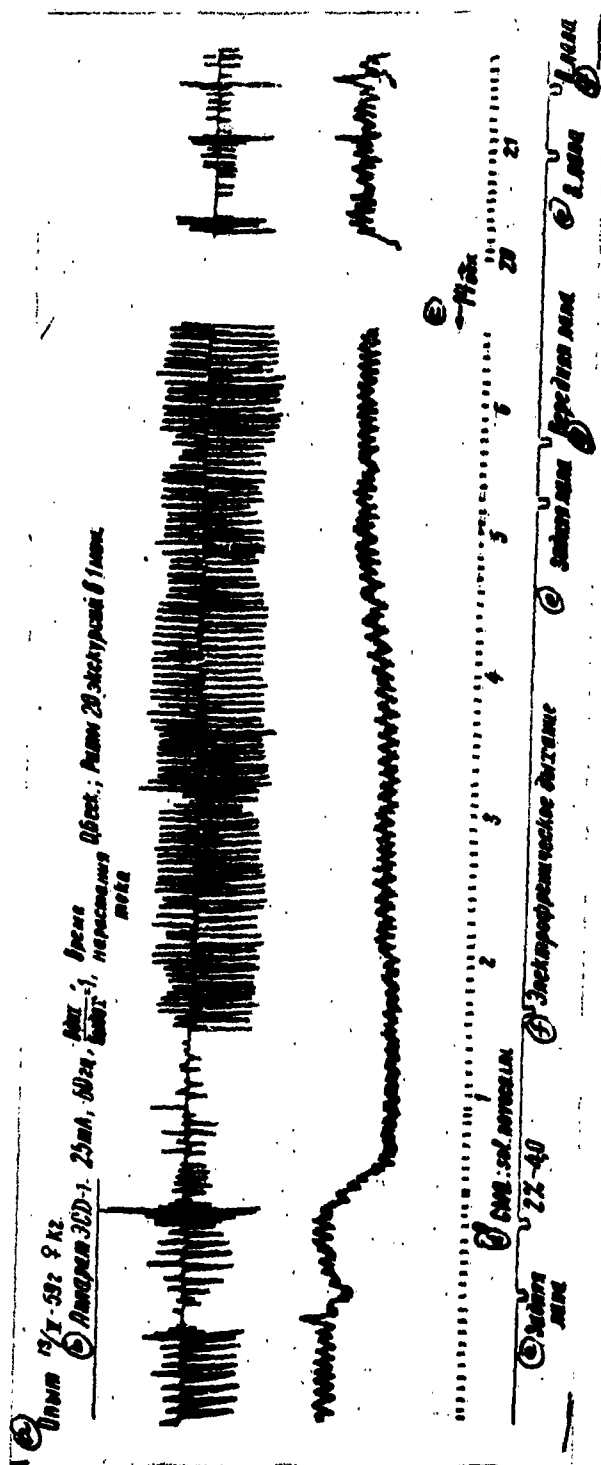


Figure 3. Kymogram of respiration and blood pressure of dog under total cerebrospinal anesthesia, using electrical stimulation of diaphragmic nerves.

LEGEND: a) Experiment on 13 May 1959, Male, 1 kg; b) ESD-1 Apparatus, 25 ma, 60 cycles, inhalation = 1, exhalation = 1, time of current increase = 0.6 sec, rhythm -- 20 strokes per min; c) seconds; d) SMA [?], 4.0 ml of 2% novocaine solution; 3) Hind paw; f) Electrophrenic respiration; g) Front paw.

Following the operation the patient reported that he did not experience unfavorable sensations during the stimulation of the diaphragmic nerves, on the contrary, at the outset of artificial diaphragmic respiration the dyspnea disappeared, although a sensation of heaviness pressing down on the chest did not leave him.

2. For patient M., 54 years of age (original patient No 2744), operated on 8 March 1960 for calculous cholecystitis, total anaesthesia and dyspnea set in ten minutes after the sub-arachnoidally administration of two ml of a 5% ephedrine solution with bubbling 3 X 6 ml and 0.7 ml of a 1% Sovcaine solution with bubbling 3 X 10 ml. Pulmonary ventilation was sustained by the electrophrenic respiration for 31 minutes. The stimulus conditions: 60 cycles, 20 ma, 16 inhalations per minutes, inhalations/exhalations -- 1, length of increase of current strength in the series of impulses (for each individual stimulus) -- 0.6 sec. Respiration was sufficiently deep and regular.

The arterial pressure following an insignificant drop (to 110/80 mm Hg) returned to the original level (150/90 mm Hg).

Following restoration of independent breathing under conditions of total anaesthesia and remarkable relaxation the operation was performed -- cholecystectomy. The patient recovered.

3. Patient R., 60 years of age, (original patient No 5766), operated on 4 May 1960 for cancer of the stomach. Total cerebrospinal anaesthesia dyspnea set in 25 minutes with increased blood pressure compared to the initial level. Electrophrenic respiration (current frequency = 60 cycles, strength = 30 ma, ratio: inhalation/exhalation -- 1, length of increase of current strength -- 0.7 sec) was deep, rhythmical, and sufficiently even.

By the 18th minute of the electrical stimulation of the diaphragmic nerves independent respiration was restored.

The operation -- a resection of the stomach according to Raychel - Poliya -- was performed under conditions of remarkable anaesthesia and deep relaxation of the musculature.

It must be noted that in this case, the muscles of the upper extremity on the side where the negative electrode was applied, synchronously with the contractions of the diaphragm, contracted. It was not possible to avoid these accompanying contractions. This may be explained either by the individual characteristics of the syntopy of the diaphragmic nerve and the shoulder plexus, or by the presence of direct anastomoses between these conductors.

4. For patient Z, 49 years of age (original patient No 3308) afflicted with an ulcerous duodenal, underwent resection of the stomach under cerebrospinal anaesthesia with hypothermy on 31 March 1960.

Two ml of a 5% solution of ephedrine (bubbling 5 X 7 ml) was subarachnoidally administered, as well as 0.7 ml of a 1% Sovcaine

solution (bubbling 1 X 10 ml). The anaesthesia spread to the angle of the lower jaw and to cool the patient ice bags were laid on him. Body temperature began to fall, and respiration became increasingly superficial.

By the 35th minute respiration ceased. The rectal temperature by this time fell from 37° C to 35.5° C.

The patient was placed under electrophrenic respiration (60 cycles, 30 ma, 16 stimuli per minutes, inhalation/exhalation -- 1, length of increase in current strength -- 0.7 sec).

By the 60th minute, with a rectal temperature of 32.5° C, the ice bags were removed, but the cooling continued up to the 80th minutes, when the rectal temperature fell to 32.1° C.

By the 45th minute of the electrophrenic respiration spontaneous inhalations began. Upon halting the electrical stimulation of the diaphragmic nerves, restoration of respiratory automatism was pronounced, however, independent respiration was superficial enough that it did not assure sufficient gas exchange even under the conditions of hypothermy; switching off of the electrostimulator led to the appearance of acrocyanosis. In this connection, against a background of independent respiration the electrical stimulation of the diaphragmic nerves was continued.

This auxiliary electrophrenic respiration differed qualitatively from controlled artificial respiration under the conditions of apnea. Up to the time of restoration of respiratory automatism, the upper level of anaesthesia for our patient reached the II rib. In this connection, unpleasant sensations were felt at the points of electrode application during the moments of electrification, when the patient experienced something like "current shocks". Moreover, spontaneous inhalations disturbed the rhythm of the electrophrenic respiration. Suppression of independent respiration was achieved only upon increasing the current strength of the stimulus, which was borne poorly on a subjective basis by the patient, who indicated soreness of the electrification.

Only after two hours 45 minutes from the start of the cerebrospinal anaesthesia, by the 125th minute of the stimulation of the diaphragmic nerves did the respiration become sufficiently regular and the stimulator was switched off.

In spite of the prolonged suppression of respiration and the substantial hyperthermia, the arterial pressure during the course of the entire period of electrophrenic respiration remained stable (between 190/110 and 100/95 mm Hg). Considering the unusually long period of apnea, the operation was postponed. After two weeks the patient was safely operated on under incubational ether-oxygen narcosis.

The last of the observations presented is of interest from many points of view. Noteworthy is the paradoxical possibility, from the point of view of the understanding of hibernation, of

producing hypothermy with the use of symphomimetic substances and high blood pressure (B. Ye. Frankenberg). Most indicative is the effectiveness of electrodiaphragmic respiration during the course of a prolonged period of respiratory insufficiency. Observation based on the characteristics of electrophrenic respiration under conditions of restored (although superficial, nonetheless spontaneous!) respiration has revealed several limits to the use of the method under clinical conditions. The possibility shown in experiment of suppressing the independent rhythm of respiration through electrification of the diaphragmic nerves under clinical conditions comes into collision with the sore sensations of the patient, which does not permit an unlimited increase in the strength of the current-stimulus. Apparently, the use of electrophrenic respiration in anaesthesiological practice proves to be most justified under conditions of narcosis and total cerebrospinal anaesthesia.

The apparatus for the electrical stimulation of diaphragmic respiration, in addition to the cases of apnea against the background of high cerebrospinal anaesthesia, were used by us ten times for severe disorders of respiration due to traumatic shock and for fractures of the base of the skull. The maximum duration of the continuous use of the ESD-1 apparatus (artificial respiration) in one of the cases of skull-base fracture amounted to 18 hours.

Changing the characteristics of the current-stimulus, the rhythm, the depth, and the evenness of respiration, as well as the ratio of the length of the phases of inhalation and exhalation can be controlled. It appears to us that with further improvement of the apparatus a long duration of current strength increase for each stimulus can be planned for, since the maximum index of the ESD-1 = 0.7 second does not assure for all the patients a sufficient regularity of inhalation. However, even the present model of the ESD-1 apparatus can be recommended for use under clinical conditions.

The preventive stabilization of vascular tonus and the assurance of artificial respiration by means of the ESD-1 apparatus practically eliminates the main dangers of high cerebrospinal anaesthesia and, according to the opinion of Professor B. Ye. Frankenberg, unfolds prospects of deliberate use of sub-total and total cerebrospinal anaesthesia for suspending pain in any operative intervention.

#### LITERATURE

- Geshelin, S. A., "Controlled Respiration under High Cerebrospinal Anaesthesia", *Khirurgiya [Surgery]* 1960, 3 145. --  
Svidler, R. S., "On Artificial Diaphragmic Respiration Using the Elektrostimulyator Dykhandiya [Respiration Electro-



stimulator/ Apparatus", Novaya medtsinskaya tekhnika /New Medical Equipment/, 1960, 2, 14-34. -- Florianovich, N. M., "Apparatus for the Electrical Stimulation Respiration", Materials for the Exchange of Experience and Scientific Achievements in the Medical Industry, 1957, 28-36. -- Frankenberg, B. Ye., "On Cerebrospinal Anaesthesia", Sovremennaya khirurgiya, /Modern Surgery/, 1936, 2, 375. -- "Anaesthetization, Hypotension, and Hypothermy with the Aid of Cerebrospinal Anaesthesia", Khirurgiya, 1960, 3, 144. Sarnoff, S. I., et al, "Electrophrenic Respiration", J. Thorac. Surg., 1950, 19, 6, 929.

Address of R. S. Svidler: Odessa, Shchepkina Street, House No 1, Apt 6.

10,123  
CSO: 2454-S

## EXPERIENCE WITH THE USE OF HYDROLYSIN L-103 IN CHILDREN

Following is the translation of an article by N. S. Anishin in the Russian-language publication Vestnik Khirurgii (Herald of Surgery), Leningrad, Vol 89, No 11, 1962, pages 131-134.

From the Second Department of Surgical Clinic (Head: Professor L. G. Smolyak) of the Donetsk Medical Institute imeni A. M. Gor'kiy, at the First City Hospital (Chief Physician: M. M. Khanovich)

Recently protein hydrolysates have found wide use in the treatment of adult patients. Only individual reports (M. M. Gubergits, A. V. Levin, M. E. Kamenetskiy, and V. A. Yur'yev) on the use of protein hydrolysates with children have been published. In the present work we present our experience with the use of the hydrolysin L-103 with children.

With regard for data on the mechanism of the action of protein hydrolysates (nutritive, stimulative, plasma-substitutive, detoxifying), we used a solution of L-103 hydrolysin as a biostimulator in the complex treatment of sick children.

We conducted 202 drip infusions of the L-103 solution for sixty-one children, chiefly in the youngest age group. These were children suffering with affections of the alimentary tract, emaciated, and undernourished.

In all, 23,830 ml of the L-103 hydrolysin solution were used.

We studied the effect of the transfusion of the L-103 solution into the child's organism on the basis of functional tests (general condition, weight, several indices of morphological and biochemical composition of the blood, and activity of the cardiovascular system). The infusions were carried out according to the instructions of the Leningrad Institute of Blood Transfusion, using only the drip method at the rate of 20-40 drops per minute, which amounted to 150-200 ml per hour. In one infusion 40-500 ml were introduced, or 20-25 ml per one kg of infant weight, at intervals from 2 to 30 days. The L-103 hydrolysin solution was not warmed to body temperature before infusion. The ampule taken from the refrigerator was joined to the system and the drip administration of the solution was commenced. Intravenous infusions numbering 25 were performed,

subcutaneous infusions -- 156, rectal infusions -- 10. The age composition of the infants and their distribution according to nature of affection are presented below.

<u>Age</u>	<u>Number of Children</u>
1-6 months	22
6-12 months	13
1-2 years	8
2-3 years	6
3-5 years	5
Older than 5 years	7
<u>Diagnosis</u>	
Suppurative pleuritis	3
Burns (trunk, face, esophagus)	12
Septicopyemia	13
Peritonitis	3
Pylorostenosis	17
Suppurative pericarditis	1
Hirschprung's disease	1
Other affections	11

Of the 202 transfusions 83 were performed before operative intervention, 80 -- during the post-operative period, and 39 -- infusions for the purpose of disintoxication.

In the treatment of most children, diet, vitamins, antibiotics, and careful nursing were used. At the same time, transfusion of the L-103 hydrolysin solution with a 5% glucose solution was carried out. The number of transfusions for each infant was determined by the severity of its affection. Most infants received from three to seven transfusions, in individual cases -- up to 30 transfusions.

The studies of N. G. Belen'kiy, A. N. Filatov, I. R. Petrov, and others have shown that the parenteral administration of plasma heterogeneous proteins, and hydrolysates permit the maintenance of hydrogen balance in the organism.

The observations recorded by us show that patients receiving L-103 during the pre- and post-operative periods, better withstand operative intervention (N. S. Anishin).

All children with pylorostenosis were received at the clinic in a serious condition with signs of hypotrophy of the second to third degree, when the dystrophic changes had lead to emaciation of the organism and the cardiac activity.

It must be noted that from the first transfusion we did not observe noticable hemodynamic improvement. The effect of the treatment led to an improvement in the general condition. A usually

good change in the condition of the child was noted after three to five drip infusions of L-103 with glucose, ascorbic acid, and vitamin B<sub>1</sub>. The children came out of their debility, they became more active. Repeated infusions of the L-103 solution for these children promoted a clearing up of the heart tones, a slowing down of the pulse, and increased blood pressure.

Administration of the L-103 solution containing glucose in large doses promoted the disintoxication of the organism, an increase in blood pressure, and the end of dehydration. Analogous favorable results have been observed by Koecher and others with the use of citrate bovine plasma with children.

It is known that the highest sensitization of the organism by the products of protein degradation is possible after 12 days.

To answer the question of the anaphylactogenic properties of the L-103 solution, we conducted repeated infusions 12-30 days following the initial transfusion, at the height of the possible sensitization. In all, 72 transfusions were carried out with 18 patients.

All these transfusions were borne by the children well and took place without reaction. It must be noted that the administration of a prophylactic dose of anti-tetanus serum to burned patients and the subsequent infusion of the L-103 solution (after 10-30 days) did not lead to anaphylactic type reactions.

For subcutaneous infusions of the hydrolysin for all children, a soreness was noted where the preparation was administered, which decreased after some days. Even after repeated infusions inflammatory reactions at the site of administration were not noticed. The resorption of the hydrolysin in this case occurred a period of 10-18 hours, depending on the amount of solution.

Hydrolysin, diluted by a 5% glucose solution in the ratio of 1:2, was administered to children under one year of age. Our experience showed that drip transfusion of L-103 containing glucose has several advantages. This method makes possible the introduction of large quantities of the hydrolysates, not overloading the cardiovascular system of the infant. In spite of the duration of the treatment, the children usually undergo it well and often fall asleep during it.

We have noted that following L-103 infusion, during the first two to three days, a decrease in the amount of erythrocytes and hemoglobin was noted. After five to twelve days an increase was recorded in the hemoglobin content of 3-8% and 700,000, for the erythrocytes. Inasmuch as the solution in question does not contain erythrocytes and hemoglobin, a certain increase in these components in the blood is a result of the stimulating action of the L-103 hydrolysin on erythropoiesis (A. N. Filatov and I. R. Petrov).

Study of the picture of the peripheral blood in the dynamics of the emaciated children (17 individuals) showed that by the second to third day following the transfusion of L-103 an increase in the

amount of leucocytes was noted for an average of 1800-2400, we noted relative lymphocytosis in 15 cases (for an average of from 22 to 38%) on the seventh to eighth day following transfusion. For lymphopenia an increase in the lymphocytes was always noted.

Regular shifts in the thrombocytes content could not be noted.

The reaction of erythrocyte sedimentation following transfusion of L-103 decreased in 40% of the cases, and in 60% remained as before. Infusion of the L-103 solution did not have a negative effect on the prothrombin forming function of the liver.

The bleeding time following repeated transfusions of the hydrolysin (200-500 ml) remained within the normal limits. Changes in the direction of coagulability of the blood following the infusion of L-103 hydrolysin did not differ essentially from those which we observed in adults (N. S. Anishin).

The protein content in the blood for emaciated children with pylorostenosis and hypoproteinemia returned to normal after several infusions.

The use of the L-103 solution in pre- and post-operative periods made it possible for the children to avoid post-operative hypoproteinemia, appearing following operative interventions on the organs of the gastro-intestinal tract.

Upon examination of the blood protein in ten patients who were given L-103, by the third to fifth day an increase in protein within the limits of from 0.6 to 1.1 g% was noted, particularly following repeated infusions. This data signifies that parenteral administration of the L-103 solution for children affords a compensation of the suspension of digestion and avoids protein starvation.

Our experience in the use of the L-103 hydrolysin with children does not yet afford grounds for conclusive judgements as far as indications and counter-indications for the use of this solution are concerned. Nonetheless it is clear that this solution has a stimulating, disintoxicating, and substitutive (in regard to the liquid fraction of blood) action. The low toxicity of L-103 and its ability to reduce intoxication make the L-103 solution valuable. It can be introduced into the organism if there are counter-indications to the transfusion of preserved donor blood. In the presence of edemas in the sick children the L-103 solution promotes their reduction.

The L-103 solution is an effective medicinal agent, which can be used along with other forms of therapy.

#### Literature

Anishin, N. S., "Some Data of the Use of the L-103 Hydrolysin Solution in Surgical Practice", Vestnik Khirurgii, 1961, 4. -- Belen'kiy, N. G., Parenteral Protein Nutrition of Man and Animals,

Moscow, 1950. -- Gubergrits, M. M., Levin, A. V., ~~K~~amenetskiy, Sh. E.,  
"Use of the Products of Acid Hydrolysis of Protein in the Treatment  
of Dystrophic Conditions", Klinicheskaya Meditsina /Clinical Medicine/,  
1949, 4, 27. -- Filatov, A. I., and Petrov, I. R., Plasma-Substituting  
Solutions, Medgiz, 1958. -- Yur'yev, V. A., "Experience of Hydroly-  
sate-Therapy for Disturbances of Nutrition in Children", Voprosy Ped-  
iatrii i Okhrany Materinstva /Problems of Pediatrics and Mother Care/,  
Vol 19, No 2, 1951.

Address of the author: Donetsk Gor'kiy Street, House No 59, Apt 14.

10,123  
CSO: 2454-S

- END -

- 25 -